Course Number: **CLIM401-001/CLIM601-001**

Course Title: **Midlatitude Synoptic Meteorology**

Instructor Name: Bohua Huang

Semester and Year: Spring 2025

Credit: 3

Class Meeting Time: 10:30 am - 11:45 am, Tuesday and Thursday

Location: In-person, Blue Ridge Hall 127

Instructor Contact Information:

Email: bhuang@gmu.edu
Office Phone: 703-993-6084

Office Hour: 1:00 pm – 2:00 pm, Thursday
Office: 269 Research Hall

Important Notice:

This course will be hosted on Blackboard for the Spring 2025 semester. Please ensure you are familiar with accessing and navigating this platform.

Resources and support are available at: https://lms.gmu.edu/getting-started-students/ to help you get started. If you have any questions, do not hesitate to reach out to me or contact the ITS Support Center for assistance.

Blackboard Login Instructions

Access to MyMason and GMU email are required to participate successfully in this course. Please make sure to update your computer and prepare yourself to begin using the online format BEFORE the first day of class. Check the IT Support Center website. Navigate to the Student Support page for help and information about Blackboard. In the menu bar to the left you will find all the tools you need to become familiar with for this course. Take time to learn each. Make sure you run a system check a few days before class. Become familiar with the attributes of Blackboard and online learning.

Course Description

This course teaches students how to apply dynamical concepts and methods in weather analysis and map interpretation. We first introduce the essential dynamical

tools for synoptic meteorology, the quasigeostrophic analysis, isentropic analysis and potential vorticity framework. Using these tools, we examine the midlatitude weather systems and phenomena, including extratropical cyclone, frontogenesis, cold-air damming and winter storm. Finally, basic procedure of numerical weather prediction and human forecasting processes are discussed.

Prerequisite:	Weather Analysis and Forecasting (CLIM301) or permission of instructor
Corequisite**:**	Atmospheric Dynamics (CLIM411) or permission of instructor

Course Learning Outcomes:

Upon completion of this course, students will

1. know the major ideas of bringing together the observational and theoretical meteorology to describe the mid-latitude synoptic weather systems.
2. gain an appreciation to the approaches and underlying values of conceptual models in weather analysis.
3. get knowledge of the basic synoptic methods and techniques.
4. be able to use the course information and skills in the interpretation of some weather phenomena.

Textbook

Required:

Garry M. Lackmann, 2015: Midlatitude synoptic meteorology: dynamics, analysis and forecasting, pp345, American Meteorological Society, ISBN 978-1-878220-10-3. (Book information: https://bookstore.ametsoc.org/catalog/book/midlatitude-synoptic-meteorology) (The textbook should be available in Mason bookstore.)

Supplemental (optional):

Gary M. Lackmann, Brian E. Mapes and Kelvin R. Tyle, 2017: Synoptic-dynamic meteorology lab manual, visual exercises to complement Midlatitude Synoptic Meteorology, pp120, American Meteorological Society, ISBN 978-1-878220-26-4. (Book information: https://bookstore.ametsoc.org/catalog/book/synoptic-dynamic-meteorology-lab-manual)

Reference

Toby N. Carlson, 1998: Mid-latitude weather systems, pp507, The Pennsylvania State University Press, ISBN: 978-0-271-05643-2. (Book information: https://www.psupress.org/books/titles/978-0-271-05643-2.html)

Requirements:

The lectures will be accompanied with homework assignments on a weekly basis. A 15-min discussion of current weather led by a student will be conducted at the beginning of each class. Some classes will be devoted to completing the exercises using the Integrated Data Viewer (IDV) software. The undergraduate grading scale as specified in the university-wide policies will be applied to CLIM401. Additional requirements for CLIM 601 are reflected in the derivations of dynamical equations and applications of the dynamical principles. The homework assignments and mid-term and final exams are given separately for CLIM 401 and CLIM 601 separately to reflect these different requirements.

Grade breakdown:

40% tests (quizzes, mid-term, final)
40% homework exercises
20% weather discussion

Grading Scale

A+ 97%-100% A 93%-97% A- 90%-93%
B+ 87% - 90% B 83%-87% B- 80%-83%
C+ 77% - 80% C 73%-77% C- 70%-73%
D 60% - 70% F below 60%

Technology Requirements

Hardware: You will need access to a Windows or Macintosh computer and access to a fast and reliable broadband internet connection. You will need speakers or headphones to hear recorded content.

Software: We use Blackboard as the learning management system. You will need a browser and operating system that are listed compatible or certified with the Blackboard version available on the myMason Portal. See supported browsers and operating systems. Also, make sure your computer is protected from viruses by downloading the latest version of Symantec Endpoint Protection/Anti-Virus software for free here.

Note: If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications and that system or corporate firewalls do not block access to any sites or media types.

Course Schedule:

Week I (01/21-01/25) **Background, a weather map view of basic dynamics** (Chapter 1)

1. Course introduction
2. Coordinate systems of weather map projection
3. Scale analysis
4. Potential temperature and equivalent potential temperature
5. Installation of Integrated Data Viewer (IDV)

Week 2 (01/27-01/31) **Thermal wind and temperature advection** (Chapter 1)

1. Geopotential height and thickness
2. Thermal wind relation and upper-level jet stream
3. Temperature advection, frictional veering

Week 3 (02/03-02/07) **Isentropic analysis** (Chapter 3)

1. Basics
2. Construction and interpretation of isentropic charts
3. Representation of vertical motion on an isentropic surface

Week 4 (02/10-02/14) **Vorticity** (Chapter 1)

1. Vorticity (relative and planetary vorticity, shear and curvature)
2. Vorticity equation
3. Vorticity and Rossby wave

Week 5 (02/17-02/21) **Quasigeostrophic framework** (Chapter 2)

1. QG approximation for vorticity equation
2. Thermodynamic equation and QG approximation

Week 6 (02/24-02/28) **QG Omega equation** (Chapter 2)

1. Physical meaning of QG Omega equation
2. Height tendency equation (map application)
3. QG potential vorticity
4. Application: Jet streak

Week 7 (03/03-03/07) **Review and mid-term**

Section review (03/04)
Mid-term (Thursday, 03/06)

Week 8 (03/10-03/14) Spring Recess

Week 9 (03/17-03/21) **Alternative expressions for vertical motion**

1. Sutcliffe development theorem
2. Petterssen's development equation
3. The Trenberth approximation
4. Q-vector

Week 10 (03/24-03/28) **The potential vorticity framework** (Chapter 4)

1. Definition
2. PV tendency equation
3. PV distribution and dynamic tropopause
4. PV changes and heat sources
5. Examples of PV inversion

Week 11 (03/31-04/04) **Extratropical cyclones** (Chapter 5)

1. Climatology of cyclones
2. An historical review
3. Cyclogenesis (QG interpretation, Sutcliffe-Patterssen view)
4. Atmospheric river and explosive cyclogenesis

Week 12 (04/07-04/11) **Frontogenesis** (Chapter 6)

1. Frontal properties and types
2. Kinematic frontogenesis
3. Dynamic frontogenesis

Week 13 (04/14-04/18) **Monsoon** (provided reading materials)

1. General property of Monsoon: Indian Summer Monsoon
2. North American Monsoon

Week 14 (04/21-04/25) **Basics of Numerical Weather Prediction** (Chapter 10)

1. Historical perspectives
2. Dynamical core
3. Parameterization of physical processes
4. Data assimilation
5. Ensemble forecasting

Week 15 (04/28-05/02) **Weather forecasting** (Chapter 11)

1. The forecasting process
2. Specific forecast parameters
3. Use of automated guidance

Final Exam (05/13, Tuesday, 10:30am-1:15pm)

Grading-related Policies

Homework Description: For each week, homework assignment is posted on Thursday. The homework assignment is due in one week on Thursday at 11:59 pm. There is no homework due in the mid-term week.

Policy for late assignments: Late homework submitted within one week after the due date is still accepted with a 3% reduction of the assigned points after each day. Homework late for more than one week is not accepted.

Quizzes: An online quiz is given at the end of each week except for the review weeks. Each quiz has five multiple-choice questions. You will have 30 minutes to complete the quiz. Quizzes are open book.

Mid-term and Final. The mid-term exam will be on March 6. The final exam will be on May 13. All exams will be closed book.

Missed exams: If you cannot attend any of these exams at the given dates and times, you should get approval from the instructor in advance. You should also arrange the next closest time to take the exam with the instructor.

Expectations for academic integrity: You are expected to be familiar with and abide by the University's Honor Code (https://oai.gmu.edu/full-honor-code-document/). Essentially, it includes the following: (1) Homework and projects submitted should be your own work, without the use of inappropriate assistance or resources. (2) When you refer to the work of others in these tasks, you must give full credit through accurate citations. (3) In creating your work, you should not take materials you are not authorized to use. It is your responsibility to see me if you have questions about these policies.

University Policies and Resources

a. Please find the **Common Policies Addendum** (via online link, PDF or document text), with policies about Academic Standards, Accommodations for Students with Disabilities, FERPA, and Title IX. A PDF copy is available in the syllabus directory on the BLACKBOARD course site.
b. Students must follow the university policy for Responsible Use of Computing
c. Student services: The University provides range of services to help you succeed academically and you should make use of these if you think they could benefit you. I also invite you to speak to me (the earlier the better).
d. Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students solely through their Mason email account.
e. The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance. Counseling Center: Student Union I, Room 364, 703-993-2380.
f. Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-

related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500, email: ods@gmu.edu, Phone: (703) 993-2474. All academic accommodations must be arranged through that office. Then please discuss your approved accommodations with me. Please note that accommodations must be made before assignments or exams are due.

g. Students must follow the university policy stating that all sound emitting devices shall be turned off during class unless otherwise authorized by the instructor.
h. The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. University Writing Center: Robinson Hall Room A114, 703-993-1200. The writing center includes assistance for students for whom English is a second language.
i. Diversity: George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.